INTERIM PROGRESS REPORT

SUBMITTED TO: NOAA's Human Dimensions of Global Change Research (HDGCR) Program

TITLE: HUMAN STRATEGIES FOR COPING WITH ENSO AND THE GROWING FLAMMABILITY OF FORESTS IN AMAZÔNIA

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GRANT NO.: NA06GP0344

TIME PERIOD COVERED: April 2002 – May 2003

DATE OF SUBMISSION: June 11, 2003

I. Preliminary Materials

A. Project Abstract

This three-year project undertakes an analysis of human coping strategies to ENSO-related drought, in light of the growing flammability of forests in two regions of the Brazilian Amazon. Recent studies suggest that 60% or more of areas currently experiencing burning in the Brazilian Amazon burn unintentionally. In the past, tropical moist forests were sufficiently resistant to fire disturbance because closed canopies maintained high moisture levels in the understory, suppressing fire penetration at ground level. Fragmentation of forests, selective logging, and other anthropogenic driving forces have opened the canopy and created warmer and drier conditions at ground level that are more conducive to the spread of fire. This drying of forests is exacerbated during ENSO events. In the most recent El Niño of 1997-98, researchers estimate that over half of forests burnt in the Brazilian Amazon during that time were a product of the unintentional spread of fire due to extremely dry conditions. Research on the extent of biomass burning and cumulative trace gas emissions in Amazônia has paid insufficient attention to the growing proportion of unintentional fires and the human dimensions of this growing vulnerability. Human vulnerability to climate varies among social groups, depending on property size, land use and technology used, and their access to forecasting information. It is not widely recognized that Amazonian forests can catch fire. This misperception on the part of scientists, policy-makers, and forecasters may be implicated in the way information is communicated to end-users. Our goal is to reconstruct the timing, content and dissemination of forecasts for the 1997-98 ENSO, trace household responses, and evaluate land-cover change in order to improve dissemination and future use of forecasts, reduce socioeconomic losses due to drought, and minimize spread of fire into forests.

To accomplish these objectives, a combination of social and environmental field research methods and analysis of remotely-sensed data are used. Field methods include archival and survey research to reconstruct the history of land use and determine: 1) people=s assessment of changing local fire spread and its relation to ENSO forecasts, 2) people=s trust in the forecasts by source, 3) how the use of the forecasts was affected by fiscal policy and by the growing health risks from the heavy smoke from fires, 4) the changing economic value of forest in each area, and 5) to measure the extent of unintentional fire spread. Interviews with policy and decision-makers will assess their awareness of ENSO forecasts, and their understanding of their relevance for the study areas. Remotely-sensed data is used to track changes in land cover, and changing land use as influenced by forecasts and changing moisture levels. The study also examines the growth of cities in these two regions, and what role urbanization may play in exacerbating or ameliorating this situation.

We have selected a medium-sized cityBSantarém (population~260,000) and a small cityBAltamira (population~85,000) and their rural periphery. The number of medium and small Amazonian cities has grown rapidly and they have notable importance in land-use and land-cover change because of growing rural-to-urban migration, and the growing proportion of urbanites= wealth in rural real estate. The process of assessment by individuals and groups as they organize to bring about reduced vulnerability to the consequences of ENSO events and to the spread of fire is of particular interest in this study. The last ENSO was accurately forecast,

85% of the population in the study areas regularly view television news programs that include information about ENSO, and yet, little is known of the coping strategies of this past forecast in order to understand how best to prepare the population for future ones, and reduce their growing vulnerability from fires.

B. Objective of Research Project

This study builds upon long-term research in Amazônia by the co-PIs, focusing upon the impact of different land-use strategies and of soil fertility upon differential rates of forest succession (in five areas, one of them Altamira), and a previous study assessing the use of fire as a land management tool by a small sample of rural dwellers in four communities south of Santarém (Sorrensen 1998; Moran and Brondizio 1998; Moran et al. 1994, 1996; Brondizio et al. 1994, 1996). These studies have pointed to the importance of biophysical factors (edge effects, amount and dryness of biomass, size of the clearing, soil fertility) and of social processes (institutions, available labor and capital, age/gender composition of households, perception of resources) in understanding changing land use and land cover (cf. Also Cochrane and Schulze 1998; Holdsworth and Uhl 1997; Possingham et al. 1995; Woods 1989). The specific objectives of the proposed study are to:

1. study two field sites in the Brazilian Amazon in order to assess the accuracy of ENSO predictions in forecasting the regional patterns of precipitation and the risk of each area to the spread of fire;
2. identify coping strategies used by stakeholders to contend with ENSO events (including indigenous forecasting techniques) and the differential vulnerability of different groups of stakeholders;
3. assess the effects of ENSO events on vegetation, livestock, crops, and different social groupings in the two study regions;
4. understand the changing perceptions and trust in the forecasts by land users and urban dwellers in small and medium-sized cities, and whether they relate these forecasts= relevance to economic and environmental losses and health risks; and
5. develop improved ways to reduce vulnerability of most at-risk groups by bringing stakeholders, forecasters and policy-makers together to discuss this study=s findings and implement local ENSO monitoring.

C. Approach (including methodological framework, models used, theory tested)

Considerable attention was given to developing a questionnaire, which allows the collection of accurate information for analysis, and enhances the efficiency of data entry, reduces errors in data entry, and permits comparison between our two study areas. The final product consists of 140 questions divided in six main sections:

1. General: characteristics of male household and his relationships to the lot
2. Characteristics of the Lot: information of land use in general
3. El Niño: perception and reactions
4. Land Use: fire use and fire management
5. Labor and technology
6. Social organization and credit

We also have a questionnaire for the female head of the household, mainly based on the questionnaire used in an earlier study on demographic dimensions of deforestation. We have radically simplified this very extensive demographic instrument to meet the needs of this project. It aims to collect information on the age and gender structure of households, and the differences they may have from the male head of household in handling forecast information and their perceptions of risk. Other questions will be introduced to capture a picture of the household economy and as a check on the information obtained from the male head of household. We have developed a database for facilitating the data entry, and drawn our stratified random sample so that it captures the differences over time in the land use developments in the region. To do so, a software application has been constructed to facilitate encoding, validation, and retrieval of questionnaire data. Validation of data, based either on its format or its deviation from the distribution of current entries, helps to eliminate errors in data entry. Retrieval of the data may be carried out on a record by record basis or by user-specified datasets. This application stores information about each of the questions for potentially several questionnaires and the responses to each for each household. It is ready to be deployed over a network as several clients with a common back end data storage. This application includes both a native GIS interface with ESRI ArcView to permit either simple orientation of the user or analysis. We have completed data entry and data cleaning for all of the male head of household surveys (N=442) at both sites, and we expect to complete the data entry and data cleaning over the rest of the summer for the female head of household surveys. We accelerated the effort on the male surveys because they dealt more directly with the issues of the level of trust about the forecast and the economic losses resulting from ENSO events.

During analysis, differences in perception between rural and urban residents will be examined, as will their changing strategies over time and space. It is assumed that greater measures may be taken to prevent fires as one gets closer to the city. Whether this is true, or whether the wind patterns make such practices ineffective, will be examined. Both cities= airports have experienced closings due to smoke from fire, and health risks have been noted by local physicians due to pervasive smoke for many consecutive days. Data collected on changes in respiratory ailments during El Niño years from the public health service, hospital, and other local agencies responsible for maintaining health records will be examined to look for trends during ENSO and non-ENSO years.

A key to making climate prediction more socially useful lies in how one develops links between those who produce the forecasts and those who benefit from the forecasts. The users need to be engaged in this process, and this becomes a serious challenge in an area such as Amazônia, with proverbially poor road infrastructure and wide gaps in education and economic status. It is hypothesized, that urban merchants who own rural properties will not necessarily be the first to hear the forecast of an oncoming El Niño, but that they will be the first to take coping strategies because of their greater trust in the forecast--the likelihood that they would lose the most from the spread of fires, and their greater capability to shift production priorities because of greater total wealth. Small rural producers will vary in their response to the forecast. Those with young families are less likely to shift production strategies than older household heads because of the lack of capital, as compared with the greater flexibility and modest capital available to older households whose cropping strategy is more diversified to start with. As part of this study we will be having two workshops, one in Altamira and one in Santarem during July 2003, where

we will bring together the forecasting community together with the user communities to undertake a process of mutual education and discussion as to how best to transmit the information needed by each group in a workshop. The results of this study will go a long way toward changing how forecasts are used by people of these two regions, and provide a strategy for improving forecasts in other parts of the Amazon Basin. Jointly, we will develop an El Niño Prediction Kit that will be cost-effectively engage local stakeholders in monitoring the magnitude and risk of future ENSO-related droughts.

We have already ordered rain gauges to distribute and are preparing a short guide for users including our collected data on ENSO and non-ENSO years to educate stakeholders on how to interpret the rain fall data they will collect and begin to pay attention to anomalous patterns and alert them through our data to the economic costs incurred by those who took part in the study.

II. Interactions

A. Description of interactions with decision-makers who were either impacted or consulted as part of the study; include a list of the decision makers and the nature of the interaction; be explicit about collaborating local institutions.

We have interacted with radio and TV station managers to find out how they obtain forecast information and transmit it. We have interacted with agricultural extension services and the agricultural research organization to find out how their information does, or does not, make its way to farmers. During Fall 2002 the PI on the grant gave five TV interviews where he explained the study, and provided some information on ENSO events. This proved to be one of the only programs actually mentioning the mild El Niño that was taking place at the time. We are collaborating with EMBRAPA in Santarem and Altamira, both of which in the past have been in charge of collecting precipitation and other climate data. In Altamira they have organized an event to take place in July 2003--a 30-year retrospective of the PI's work in the region--to which community leaders and heads of organizations have been invited. This retrospective is in addition to the climate forecast workshop with stakeholders that will take place at each site.

B. Description of interactions with climate forecasting community (i.e., coordination with NOAA climate forecasting divisions, the International Research Institute for climate prediction (IRI), regional or local climate forecasting entities, etc.)

Because it is very important for us to time our research when and if there is another ENSO event, we have been in communication with IRI and monitoring NOAA's web page and its ENSO forecast. As we analyze our data in greater detail, we will try to share our results with local entities and IRI as well.

C. Coordination with other projects of the NOAA Climate and Societal Interactions Division (i.e., other HDGCR, Research Applications, or Regional Integrated Sciences and Assessments projects)

We have to date not had interactions with other projects, except for the one led by Kathy Galvin in Africa, and the one led by Tim Finan in Northeast Brasil, but we expect this to

increase as a result of contact with other PIs at the AAG meeting, thanks to the session organized by Nancy Beller-Sims and Caitlin Simpson.

III. Accomplishments

A. Brief discussion of research tasks accomplished. Include a discussion of data collected, models developed or augmented, fieldwork undertaken.

We had two field seasons in 2002. In Summer 2002 we completed data collection at the Altamira Site, and in the Fall 2002 we completed data collection in Santarem. We completed the collection of 271 household surveys at Santarem , and another 171 households at the Altamira site for a total of 442 households. This work required the efforts of a large team for several weeks in the Amazon using two to three vehicles. A pair of interviewers went to each household--one to interview the male head of household, the other the female head of household. We also collected GPS information to accurately locate each household in the satellite images, and visited their farm fields to ensure that we understood their activities. We have carried out the remotely-sensed analysis of land cover classes and change, and verified the accuracy of the classification in the field. We acquired a more recent image (2001) which we took with us in the second field season. We worked on improving the property grid map that is overlaid over the time series of Landsat data and contacted local agencies to try and find some better maps of the properties. Some additional maps were located and we have now entered those. We have collected archival data from newspapers, visited radio stations and TV stations to discuss their forecast information. We collected some histories of the two study regions and visited archives, such as the Centro Cultural Bonarges Sena which has a good collection of newspapers, some radio transcripts, and other valuable materials. They are helping us coordinate the Workshop this July.

We visited a number of relevant government agencies and met with the heads and relevant staff. The agencies visited included the Colonization and Settlement Agency (INCRA), the Bank of Brazil, Brazil's Environmental Protection Agency (IBAMA), the Geography and Statistics Bureau (IBGE), the national agricultural research foundation (EMBRAPA), and the extension service (EMATER). We also visited with intermediaries in marketing commodities and with merchants to assess product prices, market chains, seasonal variation in prices, and strategies to improve marketing of commodities.

To improve image classification we collected over 100 additional training samples, and we are buying IKONOS satellite data, at 1 to 4 meter resolution to improve our assessment of fire risk at community level. To assess accidental fire risk we monitored 40 plots before and after the burning season. Training samples were applied for a target vegetation and the adjacent areas. In addition, a detailed interview with the owner of the area was undertaken to get information on fire management, land use history, farm management, techniques used to manage fire, and the number of days without rain used to decide on the timing of the burn. We used GPS devices to map the target areas for burns, and the location of accidental fires. A detailed protocol was used to assess the quality of the burn, the frequency of accidental fires, and the presence or absence of fire control techniques.

The household questionnaire included questions on land ownership, property regimes, family demographic and employment history, assets, social organizations, rules that governed fire use, and the history and frequency of accidental fires. We also interviewed groups of farmers, leaders, and NGOs to obtain their perspectives on fire risk and vulnerabilities.

B. Summary of any preliminary findings (i.e., how this research advances our scientific understanding)

We have only recently (in March) begun analysis of our male head of households data. In our first paper we are sharing a number of preliminary findings: that the 1997-98 ENSO is the most salient, and that 1982 was also quite memorable. However, nearly half of the households sampled did not remember a dry or ENSO year ever. We believe this is because 2000 and 2001 have been spectacularly wet years, and this has erased memories, and impacts, from the 1997-98 event. We have been quantifying the fire scars in the study area for the 1997-98 event and they are extensive. The economic losses remembered are loss of fences and barbed wire mostly, but grass seems to recover quickly with the arrival of rains. In Santarem there are few losses of perennial crops due to their relative absence, while in Altamira where cocoa plantations exist the farmers have forsworn the use of fire since the losses from the 1982 ENSO. There is very little trust in the forecast information, but this is largely due to the generality of the forecast that is transmitted in the media (e.g. it will rain today in the Amazon….). Many people indicated that they thought science could improve the quality of the forecasts, but that it needed to be more local in nature. The role of the media seems crucial in the salience of ENSO events, with1997-98 receiving the most attention (and is still vividly remembered for that reason), while the current year ENSO was never discussed as such in the media and is simply not recognized by local peoples.

C. List of any papers and presentations arising from this project thus far; please send reprints of journal articles as they appear in the literature.

We are preparing a revised version of our AAG paper for publication which we hope to send out for review this coming month. We will, of course, send copies of these reprints as they appear. There are several manuscripts in preparation.

D. Discussion of any significant deviations from proposed work plan (e.g., delayed fieldwork due to late arrival of funds).

The only change is the dropping of the two micromet stations at the request of NOAA on the basis of the panel review and due to budget cuts. Other than that, we are pursuing the work as stated in the proposal. We were able to surpass the size of our sample--from the 120 at each site that we foresaw in the grant proposal, to 171 at Altamira and 271 at Santarem. This should increase the power of the analysis. The larger sample in Santarem takes into account the larger population of the Santarem urban and rural areas as compared to Altamira.

IV. Relevance to the field of human-environment interactions

A. Describe how the results of your project are furthering the field of understanding and analyzing the use of climate information in decision-making.

This is the first study to examine how ENSO affects rural and urban populations in the Amazon, and the coping strategies of the population to the 1997-98 ENSO, and we plan to see the responses also to the currently forecast ENSO. In Brazil it does not appear that the climate community felt that it was worthwhile calling this an ENSO event. However, in October some farmers were describing this ENSO as almost as severe in the early stages as the one in 1997-98.

One of the challenges of global change research is to make scientific information more relevant to decision-makers at the local and regional level. This study has already begun to engage local actors (NGOs, government agencies, TV and other local media, information Abrokers@, and individual land users) in the process of evaluating the use of climate forecasts. All those interviewed expressed surprise when they discovered that the Aother@ agency also had not transmitted a local forecast. It seems each media source assumed another media was doing so! The 1997-98 ENSO is the focus of attention, but other forecasts are being used in assessing the use of information. In addition, experiments in focus groups will be conducted with the above local informants to see how severity, magnitude, and other characteristics of the forecast influence their propensity to make different decisions about the use of fire, the use of land, and other economically relevant strategies (e.g. sell cattle, not harvest crops). The impact of drought is mediated by access to adaptive technologies, crop prices, subsidies and insurance. Access to these adaptations is highly variable by region, sector, and social group. Smallholders, for example, have been noted to lack the financial and technological means to make firebreaks, but some of them do--Why? ENSO can be forecast with three to twelve-month advance notice, and the potential impacts of ENSO on agriculture, health, water resources, and fire can be evaluated before, during and after the event. Since the Altamira-Santarém region is considered a particularly important agropastoral production zone, a goal of the study is to evaluate how well decision-makers use available information and adaptive technologies to reduce vulnerability of people in the region. Does the size of the city influence the flow of information or trust in it? Are the dominant crops particularly vulnerable to precipitation shortfalls (pasture vs. tree crops)? Does one region have a more effective method of delivering climate forecast information than the other? Are special fiscal instruments made available in a timely fashion to reduce risks to all, or only some, stakeholders?

B. Where appropriate, describe how this research builds on any previously funded HDGEC research (i.e., through NSF, EPA, NASA, DOE, NGOs, etc.)

This research builds on earlier work funded by NSF and NASA. These other studies permitted accumulation of very detailed data on vegetation, soils, and land cover classes. The current work under NOAA allows us to address the coping strategies of farmers and their responses to the possibilities of widespread fire risk as a result of drought associated with ENSO. Without this support, we would not have addressed these fire-related questions.

C. How is your project explicitly contributing to the following areas of study?

1. ***Adaptation to long-term climate change:*** The proposal addresses the question of how people adapt or cope with ENSO events. One key question is whether past ENSOs are remembered and affect future decisions taken by people. Many people seem to have forgotten the severity of the event after four years. Those who remember are very detailed in how they were affected. While last year we thought that people remembered the ENSO that took place when they first came to this region, rather than the most recent one, analysis since completion of the sample suggests that there is no statistical correlation between year of arrival and the ENSO most remembered.
2. ***Natural hazards mitigation:*** We are examining what, if anything, farmers do to mitigate the risk of fire normally, and in years when ENSO is forecast. It seems that there are routine practices to mitigate the risk of fire (such as windrows), but to date very few strategies that go further than that seem to be taken.
3. ***Institutional dimensions of global change:*** There are some local institutions that are mobilized to ensure that people use mitigating behaviors, but this seems at present to be mostly NGOs such as IPAM, which conducts clinics and workshops on fire control.
4. ***Economic value of climate forecasts:*** The forecast given locally seems to be very general and of very little local relevance, so the forecast does not appear to have major economic impacts. However, once an ENSO is forecast at national scale, there are efforts to communicate specific local relevance. Hopefully, we will be able to see this during the coming field season if ENSO continues to develop.
5. ***Developing tools for decision makers and end-users:*** We hope to develop such tools after the field research and have been asking what sorts of tools will be of most value to end-users.
6. ***Sustainability of vulnerable areas and/or people:*** That is a strong focus of our work, so we are doing a careful assessment of the multiple resources available to households and their vulnerabilities.
7. ***Matching new scientific information with local/indigenous knowledge:*** We have found some local systems for forecasting and we will be trying to see how well they match up with scientific forecasts. It appears that the system most widely used was developed for the conditions of Northeast Brazil and that it has poor adaptability to the precipitation patterns in these regions of the Amazon.
8. ***The role of public policy in the use of climate information:*** Clearly, we will be watching to see how public policies respond to the forecast of ENSO. Because of the mild ENSO in 2002-03, there was little response or information about it provided.
9. ***Socioeconomic impacts of decadal climate variability:*** This is not part of our research.
10. ***Other (e.g., gender issues, ways of communicating uncertain information):*** We are addressing male and female differences in perception of risk and understanding of the forecast to see if there is gender specific knowledge or ways of disseminating information.

V. Graphics

A. Map of regions covered by study – attached (Page 10)
B. Photographs from fieldwork to depict study environment – attached (Pages 11-13)

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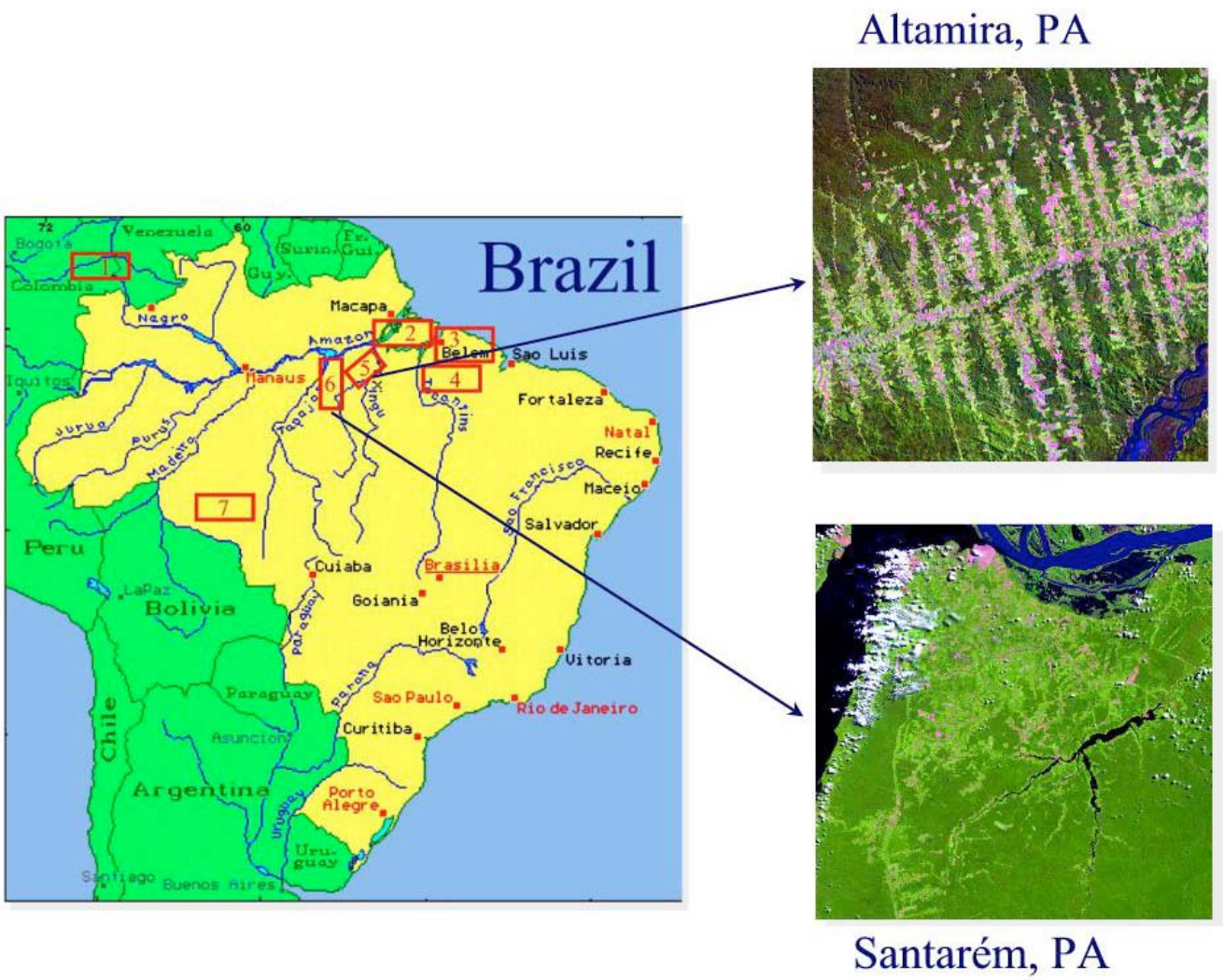
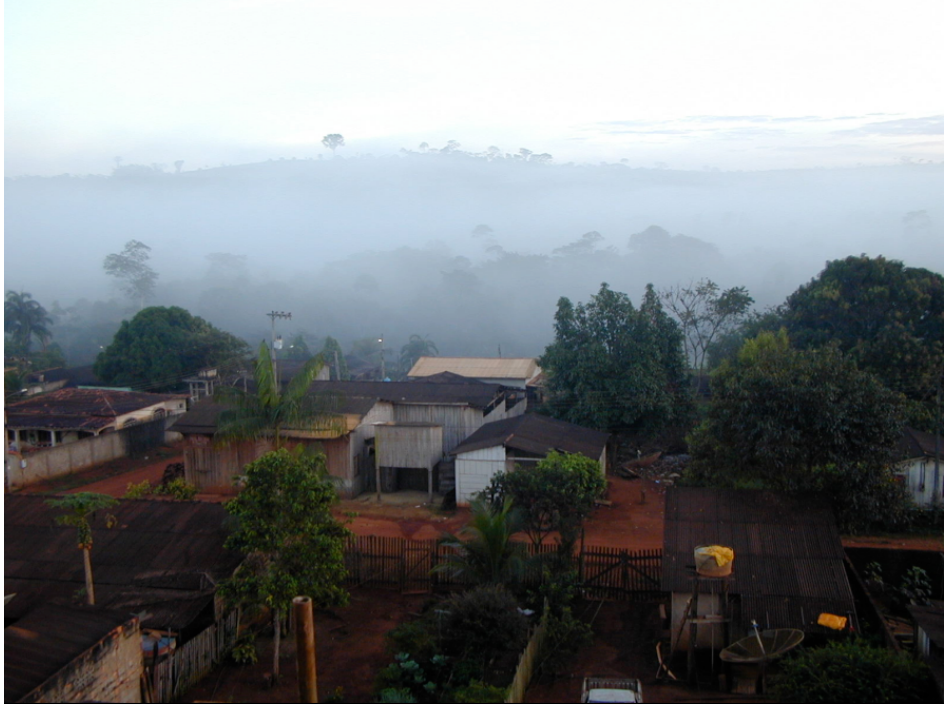
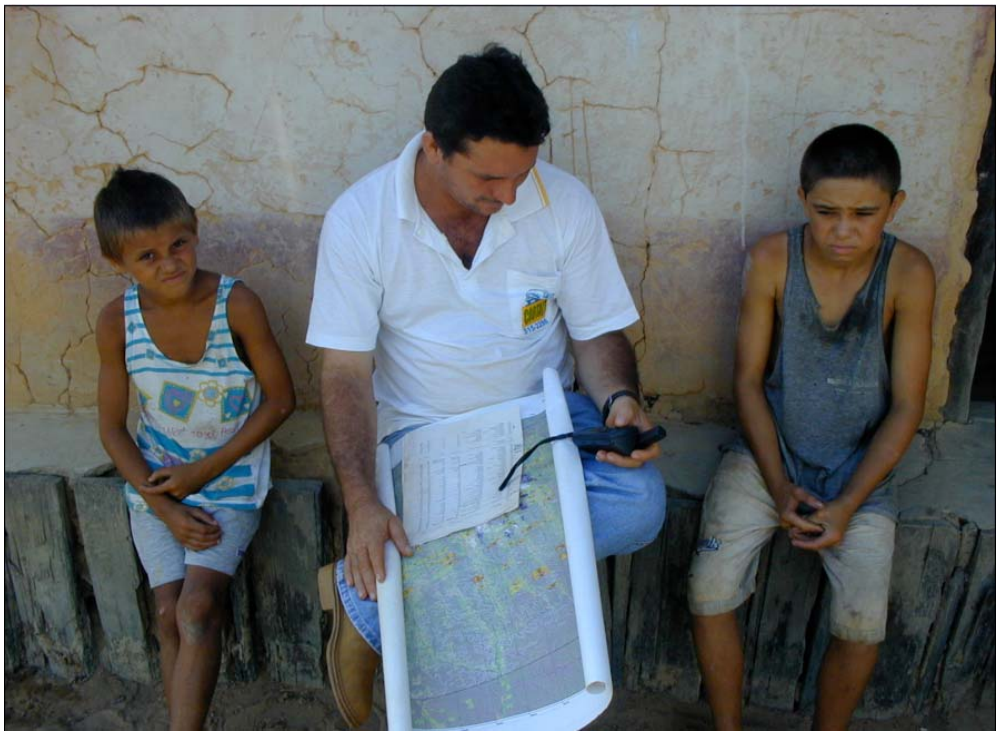
NOAA Project Study Areas



Rafaela, one of our interviewers, with a female head of household and her children.

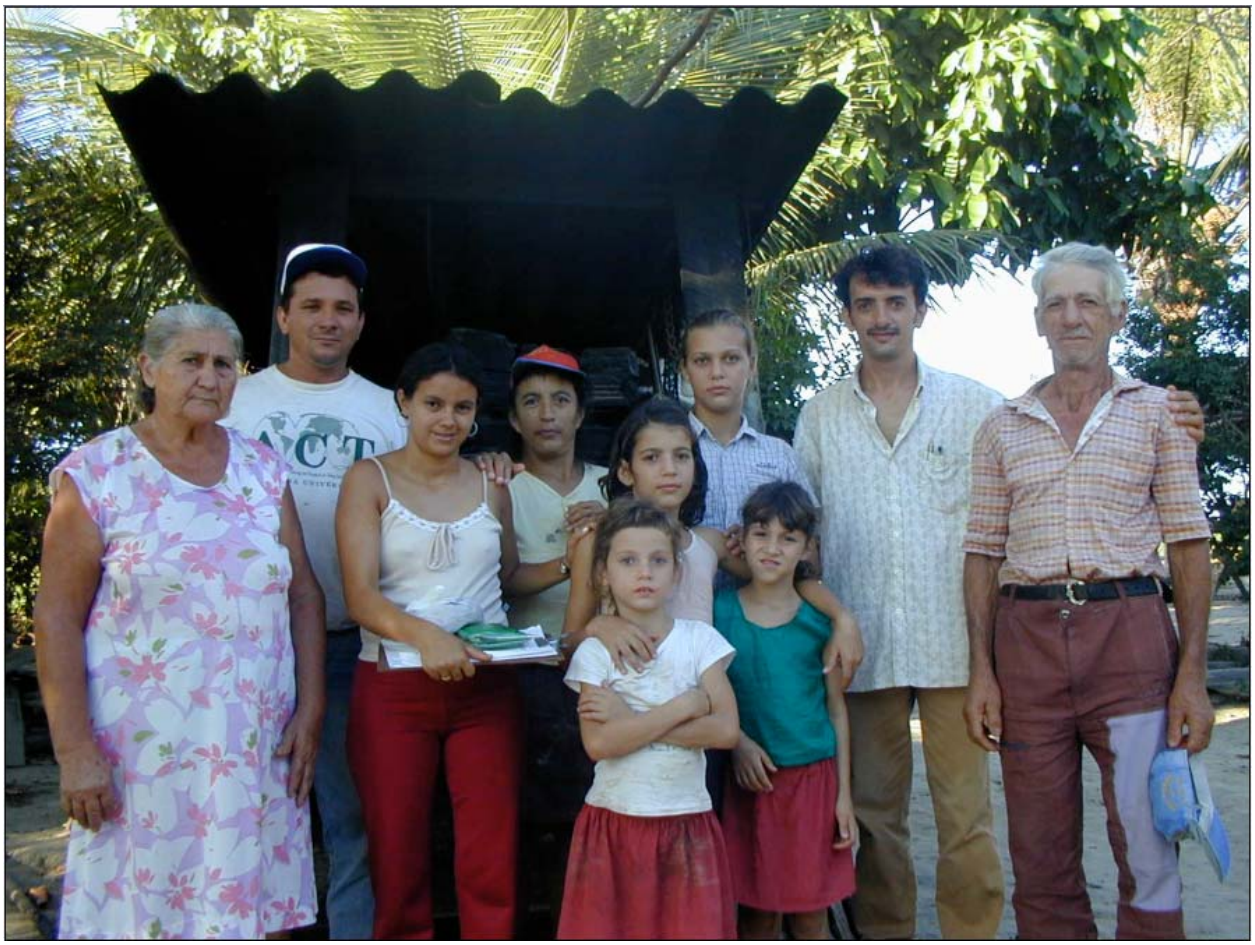


View of Medicilandia, a town in the Altamira study region, at dawn as we set out for field research.



Use of GPS in the field allowed team members to be sure of the location of properties in the random sample.

One of the better off households with above average flooring and walls, during interview.



Our team gets to know the families very well during the long interview and they welcome a family picture as remembrance of the day. We commonly return the next day after we print the digital pictures and share a copy with the families.